CULTURAL AND ENVIRONMENTAL EFFECTS ON SEVERAL SEEDLING EMERGENCE TRAITS OF WINTER WHEAT (*TRITICUM AESTIVUM* L.)

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OF WINTER WHEAT (<u>TRITICUM</u>
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CHAPTER I

INTRODUCTION

Stand establishment is a key factor in successful winter wheat (*Triticum aestivum* L.) production. Oklahoma wheat farmers are often faced with a dry soil surface at planting time. In these situations they frequently plant deep enough to reach moisture which can potentially reduce wheat seedling emergence. Many of the seedling emergence traits thought to be important to stand establishment have not been studied on cultivars commonly grown in Oklahoma. Therefore, the objective of this research was to evaluate the effect of cultural and environmental factors on the seedling emergence traits of winter wheat cultivars grown in Oklahoma.

Two experiments were conducted to evaluate wheat seedling emergence traits. Chapter II reports the effect of temperature and planting depth (in a growth chamber situation) on coleoptile length, crown depth, mean day to emergence and percent emergence of seven winter wheat cultivars. In Chapter III, the effect of planting depth and seed size on coleoptile length, crown depth, percent emergence, tiller number and grain yield on four winter wheat cultivars grown under field conditions is discussed.

Chapter IV is a brief summary of the results obtained in Chapters II and III. These chapters are written in a form acceptable for publication by the Agronomy Journal.

CHAPTER II

TEMPERATURE AND PLANTING DEPTH EFFECTS ON SEVERAL SEEDLING EMERGENCE TRAITS OF WINTER WHEAT

Abstract

Seven winter wheat (*Triticum aestivum* L.) cultivars, representing those commonly grown in Oklahoma, were studied under growth chamber conditions to evaluate the effect of temperature and planting depth on coleoptile length, crown depth, mean day emergence, and percent emergence; traits which can potentially affect stand establishment. Two semidwarfs ('TAM W-101', 'Vona'), three tall semidwarfs ('Wings', 'Newton', 'TAM 105'), and two tall ('Osage', 'Triumph 64') cultivars were sown at 7.5, 10.0, and 12.5 cm depths in four day-night temperature regimes (32/23, 26/18, 21/12, 15/7 C). Soil texture was a sandy clay loam. Tall cultivars, in general, had longer coleoptiles than semidwarfs. The exception was TAM 105 which exceeded the tall cultivars at the two lower temperature regimes. Coleoptile length always increased with planting depth and was drastically reduced at 32/23 C for all cultivars. Cultivar emergence ranged from 87.1 to 91.7% when averaged

over temperature and planting depths. Emergence generally declined with planting depth. Mean day to emergence (MDE) was delayed as temperature decreased and planting depth increased. The greatest reduction in MDE occurred between 15/7 and 21/12 C. The difference between the lowest (Osage) and highest (TAM W-101) MDE was only slightly more than one day and was considered of little practical importance. The semidwarfs (Vona, TAM W-101) generally formed the deepest and the tall cultivar, Osage, the shallowest crowns at each temperature and planting depth. Crown depth increased for all cultivars with increased planting depth and the shallowest and deepest crowns formed at 26/18 and 15/7 C, respectively. The differences in morphological traits between the cultivars were shown not to have great importance in stand establishment under the conditions studied.

Additional index words: *Triticum aestivum* L., Coleoptile length, Crown depth, Mean day to emergence, Emergence.

Introduction and Literature Review

The first step toward successful winter wheat (*Triticum aestivum* L.) production is stand establishment. When sufficient moisture is available at planting time, shallow sowing at 2.5 to 4 cm will usually produce good stands (17). However, it is not uncommon in Oklahoma for farmers to be faced with a dry soil surface at planting time. Under these circumstances they have only three choices: plant deep to moisture, delay planting, or dust the seed in. Probably the most frequent choice has been to seed deep enough to reach moisture, which has often resulted in drastic reductions in the emergence of wheat seedlings.

The main reason wheat farmers in Oklahoma plant early is to establish pasture for fall and winter grazing. Along with the problem of low soil moisture, early sown wheat is also exposed to high soil temperatures. Research has shown that both deep seeding and high soil temperature can reduce stands (7, 8, 19, 22).

Several workers have noted the importance of coleoptile length in the emergence of winter wheat. Burleigh et al. (7) and Whan (22) observed that standard height varieties had longer coleoptiles than semidwarfs and generally a higher percent emergence when sown at depths ranging from 4 to 15 cm. Chambers (8) described a normal type emergence as when the coleoptile emerged from the soil before the appearance of the first leaf. Emergence was considered abnormal when the coleoptile failed to reach the soil surface and the first leaf emerged from the soil. In this case, emergence depended upon the first leaf's ability to penetrate the remaining soil barrier. Using 'Gabo' wheat he found that percent emergence decreased when a greater number of coleoptiles failed to reach the soil surface. Coleoptile length has also been found to increase with planting depth

(4, 19).

Burleigh et al. (6) and Bhatt and Qualset (5) studied the effect of temperature on coleoptile length. They found, in general, that maximum coleoptile length occurred between 15 and 21 C with considerably shorter coleoptiles at 32 C. A significant genotype x temperature interaction also occurred when the temperature utilized ranged from 10 to 32 C (5).

Allan et al. (3) and Sundermann (19) examined the relationship between emergence rate, mature plant height, percent emergence and coleoptile length for several experimental lines and cultivars. Significant differences in emergence rate between varieties were found. Coleoptile length was positively correlated with (1) emergence (r=0.82 to 0.93) at depths of 7.5 to 12.5 cm, (2) emergence rate (r=0.16 to 0.55), and (3) plant height (r=0.55 to 0.76). Coleoptile length in laboratory tests were highly correlated with coleoptile length in the field (r=>0.90). Dubetz et al. (12) noted that the rate of emergence of wheat cultivars increased as soil temperatures increased from 6 to 24 C. Singh and Gill (18) reported the optimal factors for wheat stand establishment to be a maximum planting depth of 4 cm and a soil temperature of 20 C.

Planting depth, cultivar, and environmental conditions may also affect crown depth. Differences of opinion exist as to the importance of crown depth for winter survival. Several authors (11, 13, 16, 20, 21) believe that cultivars with deep crowns are more winter hardy. Ashraf and Taylor (4), however, reported winter survival to be associated with shallow crowns. Sallan (16) and Ferguson and Boatwright (13) suggested that crown roots were less likely to develop under dry soil conditions if the crown depth was shallow. General field observations indicated that in many instances plants without crown roots died during the winter, whereas neighboring plants with crown roots survived (13).

Webb and Stephens (21) observed variation between cultivars in the elongation of the subcrown internode, which determines the crown depth of the plant. They also found that crown depth is influenced by temperature and depth of seeding. Both deep planting and low soil temperatures caused crowns to form at slightly greater depths. Taylor and McCall (20) also found subcrown internode length to increase with temperature and seeding depth. Ashraf and Taylor (4) observed significant differences in subcrown internode length for cultivars and planting depths. Chambers (9) suggested that deep sowing caused unnecessary elongation of the subcrown internode which depletes the food reserve in the grain and could result in poor emergence. Subcrown internode length was closely associated with coleoptile length ($r=0.79$) and culm length ($r=0.77$) according to Allan and Pritchett (1). Coleoptile length, subcrown internode length, seedling emergence rate, and total seedling emergence were positively interrelated in most wheat selections in a study conducted by Chowdhry and Allan (10).

Information on the seedling emergence traits of several cultivars grown in Oklahoma when subjected to different planting depths and soil temperatures is lacking. Such information would assist the farmer in selection of specific cultivars matching his particular field situation. Consequently, the objective of this study was to evaluate the effect of temperature and planting depth on coleoptile length, crown depth, percent emergence, and mean day emergence for several cultivars representative of those commonly grown in Oklahoma.

Methods and Materials

Seven winter wheat cultivars consisting of 'Osage', 'Triumph 64' (talls), 'TAM 105', 'Newton', 'Wings', (tall semidwarfs), 'Vona', and 'TAM W-101' (semidwarfs), were studied under growth chamber conditions. Selection of cultivars was based on previous knowledge of mature plant height since plant height and coleoptile length have been reported to be highly correlated (3, 19).

The seed source for each cultivar was 1981 foundation seed. Laboratory germination for each cultivar was: TAM W-101 and Wings, 98%; Vona, 97%; Triumph 64, 96%; TAM 105, 95%; Newton, 94%; and Osage, 90%. Although seed size has been shown to affect early seedling vigor in wheat (15), bulk seed was used to more effectively simulate what would happen in a commercial production field. The bulk seed lots were sized, however, to determine the relative uniformity of seed size within each cultivar. It can be seen from Table 1 that all cultivars were relatively uniform for this trait.

Thirty seeds of each cultivar were sown in wooden flats (60 cm x 27 cm x 18 cm) at 7.5, 10.0, and 12.5 cm depths in four day-night temperature regimes (32/23, 26/18, 21/12, 15/7 C). Photoperiod was 12 hours. Holes were drilled in the bottom of each flat to permit drainage and aeration. Soil texture was a sandy clay loam with a bulk density of 1.2 g/cm^3. I attempted to simulate field soil conditions in which surface crusting would not be a factor. This was done by supplying adequate moisture to the underlying soil at the time of sowing and placing a 4 cm layer of air dried soil as the top layer for each planting depth. Polyethylene covers were placed over each flat after sowing to reduce moisture loss through evaporation and were removed upon the emergence of the first seedling. These procedures prevented the need for surface waterings throughout the growing period.

Emergence counts were made once a day throughout the growing period. The mean day to emergence (MDE) was calculated as follows: $MDE = \Sigma(XY)/Z$ where X = number of days since test initiation, Y = number of seedlings emerged on X day, and Z = total number of seedlings emerged.

Seedlings were removed once the crown could be identified. Coleoptile length, subcrown internode length, crown depth, and percent emergence were recorded. Percent emergence was calculated using only the germinated seeds. Crown depth was determined by subtracting subcrown internode length from planting depth. Since crown depth is inversely correlated with subcrown internode length, only data for crown depth will be reported in this paper.

Correlations were determined for all variable combinations at each temperature and planting depth. Cultivars were grouped according to mature plant height. The coleoptile/crown depth correlations were calculated on an individual plant basis while correlations involving other variable combinations were determined using treatment means.

The experimental design was a split plot with the main plot as planting depth (flats) and the subplot as cultivars. There were three replications. The experiment was repeated and the data combined in order to test for temperature effects.

Results

Results from the analysis of variance for the four traits of interest are presented in Table 2. The main effects (temperature, planting depth and cultivar) were highly significant for both coleoptile length and mean day to emergence (MDE). The temperature by cultivar and depth by cultivar interactions were significant for coleoptile length, whereas only the first order interactions involving temperature were significant for MDE. Temperature was not important in determining percent emergence or crown depth. However, these traits were affected by planting depth and cultivar. The only interaction of significance for percent emergence was temperature by depth. Both first order interactions involving cultivars were significant for crown depth.

Coleoptile Length

In general, coleoptile length was longest with the tall cultivars at low temperatures and deep planting depths (Table 3). The primary exception to this trend was TAM 105, which is an intermediate height cultivar (tall semidwarf). Coleoptile length of TAM 105 exceeded that of Osage and Triumph 64 at the two lower temperature regimes regardless of planting depth.

The response of cultivars for coleoptile length was relatively uniform as the temperature increased from 15/7 to 32/23 C (Figure 1). The changes in rank and magnitude explain the significant temperature by cultivar interaction that was obtained. In general, coleoptile length for the semidwarf cultivars was longest at the low temperature and declined as temperature increased. Osage maintained a relatively stable coleoptile length at the three lower temperatures, then declined dramatically at 32/23 C. Triumph 64 showed a definite preference for the intermediate temperatures.

Among the three highest temperature regimes, cultivars could be divided into three groups based on coleoptile length (long, intermediate, short). These groups did correspond to mature plant height with the exception of TAM 105. Respectively, the three groups were: long - Osage, Triumph 64, and TAM 105; intermediate - Newton and Wings; short - Vona and TAM W-101.

The effect of planting depth on coleoptile length and the explanation for the significant planting depth by cultivar interaction can be seen in Figure 2. Coleoptile length always increased with planting depth. The magnitude of this increase in length varied among cultivars but was less as temperature increased, especially for the semidwarfs (Table 3). The cultivar groupings mentioned for temperature are also evident here.

Emergence

Cultivar performance for percent emergence at different temperature regimes and planting depths is presented in Table 4. There were generally no differences among cultivars at the 7.5 and 10.0 cm planting depths for all temperatures, with the exception of Newton at the 10.0 cm depth. Both Newton and Osage were significantly lower than the top cultivar when sown at 12.5 cm and 15/7 or 21/12 C. Percent emergence ranged from 87.1 (Newton) to 91.7% (TAM W-101) when averaged over temperature and depths.

The interaction between temperature and planting depth on percent emergence is shown in Figure 3. Emergence generally declined with planting depth, with the exception of 32/23 C, where percent emergence was relatively stable across planting depths. As planting depth increased, the effect of temperature on emergence became more important, with the highest emergence occurring at the two higher temperature regimes.

Mean Day to Emergence

Even though differences were detected among cultivars for mean day to emergence (MDE), they were small and probably of little practical significance. The difference between the lowest (Osage) and the highest (TAM W-101) MDE, within each planting depth and temperature, was only slightly more than one day (Table 5). The effects of temperature and planting depth, however, were significant. In general, emergence was delayed as temperature decreased and planting depth increased (Figure 4). Temperature was the most important factor. The greatest reduction in MDE due to temperature occurred between 15/7 and 21/12 C, with the magnitude of the effect depending on planting depth and cultivar. The greatest delay in emergence (7.9 days) occurred with Triumph 64 at 12.5 cm between 15/7 and 21/12 C. The largest effect of planting depth (2.9 days) was with TAM W-101 at 15/7 C between 7.5 and 10.0 cm.

Crown Depth

The semidwarfs (TAM W-101 and Vona) generally formed the deepest and the tall cultivar (Osage) the shallowest crowns at each temperature and planting depth (Table 6).

Although significant differences for temperature were not detected, a definite trend could be seen for all cultivars. In general, the temperature regime most conducive to the formation of shallow crowns was 26/18 C (Figure 5). Crown depth increased as temperature either increased or decreased from that point. In all cases, the deepest crowns were formed at 15/7 C. TAM W-101 maintained the deepest crown as the temperature increased, whereas the other cultivars had a more uniform response. TAM W-101 and Newton were the least responsive to temperature change, and Triumph 64 the most between 15/7 and 26/18 C. There was little change in crown depth for Osage, Triumph 64, and TAM 105 between 26/18 and 32/23 C.

The effect of planting depth on crown depth and the explanation of the planting depth x cultivar interaction is shown in Figure 6. Crown depth increased dramatically for all cultivars with increased planting depth. The three tall semidwarfs (Wings, Newton, and TAM 105) and the tall cultivar (Triumph 64) formed a group with intermediate crown depths, while the semidwarfs (TAM W-101 and Vona) and the tall cultivar (Osage) had deeper and shallower crowns, respectively. The differences between cultivars increased dramatically as planting depth increased.

Correlations

None of the traits examined in this experiment were strongly correlated. Correlation coefficients ranged from -0.25 to -0.51 between crown depth and coleoptile length for each cultivar height class at 21/12, 26/18, and 32/23 C. Positive correlations were obtained between these traits at 15/7 C, but they were very small (r=0.07 to 0.20). Correlations involving other variable combinations were not significantly different from zero.

Discussion

Previous work (7, 22) stated that standard height varieties had longer coleoptiles than semidwarfs. This study is in agreement with these conclusions, with the exception of TAM 105 (a tall semidwarf). Evidently, the linkage that exists between coleoptile length and mature plant height was at least partially broken in this case. I found no significant correlations between percent emergence and coleoptile length, and no differences in percent emergence due to high temperatures as reported by others (7, 19, 22). Increased planting depth did generally decrease emergence but not to the extent reported by these authors. These discrepancies are probably due to differences in experimental methods. In this study, the top soil layer consisted of 4 cm of air-dried soil. Additional surface water was not applied, which eliminated the potentially confounding effect of crusting. Consequently, even though all cultivars had abnormal type emergence (as defined by Chambers (8)), the first leaf was able to penetrate the soil and emerge in most instances. It is suspected that farms of like soil texture sown to similar depths with loose surface conditions will produce a good stand, providing rain does not cause a surface crust to form prior to emergence. It is felt, however, that coleoptile length is still important for good emergence, a point which may become more evident when surface crusting is present. TAM 105, which was similar to the tall cultivars in coleoptile length, would be a good selection when farmers are faced with a deep sowing situation and desire a shorter-strawed cultivar.

The effect of temperature and planting depth on coleoptile length was in agreement with other studies (4, 5, 6, 19). It is interesting to note, however, that in this study the coleoptile failed to reach the soil surface in all cases, even though the potential to do so existed. For instance, the coleoptile length for TAM 105 was 82 mm at 15/7 C and 10.0 cm, a length which exceeds the 75 mm of the shallow planting depth. Consequently, it is suspected that there are factors other than light (14) that inhibit coleoptile extension (7). Allan et al. (2) suggested that reduction in coleoptile length caused by high temperature (32 C) was a result of reduced cell elongation and not differences in cell number.

Mean day to emergence decreased with increasing temperature and shallower planting depth, which agrees with work done by Dubetz (12). However, no significant correlations between MDE and coleoptile length were obtained as were by Allan et al. (3). In general, these results indicated that there is no practical difference between cultivars for emergence rate, regardless of soil temperature or planting depth. It may also be of practical importance to note that there was little difference among planting depths for MDE at the two high temperature regimes. This suggests that a farmer could plant to 12.5 cm to reach moisture and not sacrifice rate of emergence.

The response of crown depth to changes in soil temperature and planting depth was similar to that of other workers (20, 21). Mature plant height did somewhat correspond to crown depth in that the semidwarfs had the deepest crowns and the tall semidwarfs and tall cultivars had shallower crowns. The strongest correlation was between coleoptile length and crown depth (ranging from $r=-0.25$ to -0.51) which is supported by the work of Allan and Pritchett (1), who found subcrown internode length (inverse of crown depth) and coleoptile length to be positively correlated ($r=0.79$).

In conclusion, I found soil temperature to have the greatest effect on the four seedling emergence traits examined, followed by depth of planting. The differences in morphological traits between the cultivars were shown not to have great importance in stand establishment under the conditions studied. A field study is under way to determine if these results will hold true under natural conditions.

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TABLE 1

PERCENT* OF SEED REMAINING ON SIEVES FOR SEVEN WINTER WHEAT CULTIVARS

	Sieve slot widths in millimeters				
Cultivars	3.2 (8/64)**	2.8 (7/64)	2.4 (6/64)	2.0 (1/13)	1.6 (1/16)
Osage	-	16	60	21	3
Triumph 64	1	40	49	8	2
TAM 105	-	7	79	10	4
Newton	-	-	6	59	35
Wings	1	4	68	25	2
Vona	-	2	28	62	8
TAM W-101	1	3	84	11	1

*by weight

**inches

TABLE 2

MEAN SQUARE FOR FOUR WINTER WHEAT SEEDLING EMERGENCE TRAITS

Source of Variation	DF	Coleoptile Length	Emergence Percent	MDE	DF	Crown Depth
Run	1	.23	161	78.45**	1	557
Temperature	3	9059.75**	288	2583.58**	3	3482
Error A	3	226.57	842	0.38	3	1736
Depth	2	3257.06**	2712**	244.46**	2	15093**
T x D	6	16.92	436**	42.62**	6	40
Error B	8	24.51	63	2.15	8	105
Cultivar	6	3221.64**	202*	10.09**	6	605**
T x C	18	153.69**	98	0.36**	18	76**
D x C	12	14.39**	111	0.20	12	43**
T x D x C	36	4.47	69	0.13	36	9
Error C	72	4.52	69	0.13	67	8
C.V. (%)		3.4	8.5	3.5		5.1

*,**Significant at the 0.05 and 0.01 levels of probability, respectively.

TABLE 3

MEAN COLEOPTILE LENGTH OF SEVEN WINTER WHEAT CULTIVARS AT THREE PLANTING DEPTHS UNDER GROWTH CHAMBER CONDITIONS IN FOUR DAY-NIGHT TEMPERATURE REGIMES

	Temperature (C)											
	15/7			21/12			26/18			32/23		
	Planting Depth (cm)											
Cultivar	7.5	10.0	12.5	7.5	10.0	12.5	7.5	10.0	12.5	7.5	10.0	12.5
	Coleoptile Length ----mm----											
Osage	68	72	76	71	75	80	69	74	79	54	59	65
Triumph 64	63	70	73	68	76	80	67	72	77	53	61	63
TAM 105	75	82	87	76	83	86	66	72	77	53	58	59
Newton	65	70	76	65	69	74	57	62	66	46	51	52
Wings	63	67	71	62	68	71	57	61	64	46	52	52
Vona	58	63	66	57	61	65	52	58	59	44	48	49
TAM W-101	60	66	70	59	64	66	49	55	58	38	42	44

LSD (P = 0.05) for cultivars within columns = 3 mm.

TABLE 4

PERCENT EMERGENCE OF SEVEN WINTER WHEAT CULTIVARS AT THREE PLANTING DEPTHS UNDER GROWTH CHAMBER CONDITIONS IN FOUR DAY-NIGHT TEMPERATURE REGIMES

	Temperature (C)											
	15/7			21/12			26/18			32/23		
	Planting Depth (cm)											
Cultivar	7.5	10.0	12.5	7.5	10.0	12.5	7.5	10.0	12.5	7.5	10.0	12.5
	% Emergence %											
Osage	95	84	73	100	93	74	97	85	90	83	90	87
Triumph 64	89	88	80	94	97	81	93	91	87	89	90	90
TAM 105	95	89	91	96	92	88	93	93	85	94	94	90
Wings	92	90	86	86	94	78	97	94	92	87	93	91
Newton	95	87	76	92	83	77	96	82	80	92	95	91
Vona	93	84	85	94	91	86	97	90	92	91	95	90
TAM W-101	96	85	86	95	90	84	95	94	85	94	88	90

LSD ($P = 0.05$) for cultivars within columns and depths at same cultivar and temperature = 10.

TABLE 5

EFFECT OF TEMPERATURE ON MEAN DAY TO EMERGENCE OF SEVEN WINTER WHEAT CULTIVARS AT THREE PLANTING DEPTHS UNDER GROWTH CHAMBER CONDITIONS

		Cultivar						
Planting Depth	Temperature	Osage	Triumph 64	TAM 105	Newton	Wings	Vona	TAM W-101
(cm)	(C)				(MDE)			
7.5	15/7	12.9	13.9	13.5	13.4	13.3	13.5	13.9
	21/12	8.4	9.0	8.9	8.8	8.7	8.9	9.4
	26/18	5.6	5.8	6.4	6.1	5.9	6.5	6.9
	32/23	5.2	5.4	5.7	5.6	5.4	6.0	6.3
10.0	15/7	15.4	16.2	16.2	16.1	16.1	16.2	16.8
	21/12	9.6	9.8	10.2	10.4	9.9	10.2	10.8
	26/18	6.5	6.7	7.1	6.9	7.0	7.4	7.8
	32/23	5.6	5.8	6.3	6.1	6.0	6.5	6.7
12.5	15/7	18.2	18.8	18.8	17.9	17.9	18.7	19.3
	21/12	10.8	10.9	11.6	11.4	11.0	11.6	11.9
	26/18	7.0	7.3	7.8	7.3	7.6	7.8	8.2
	32/23	5.9	6.0	6.8	6.2	6.3	6.6	7.0

LSD (P=0.05) for temperatures at the same cultivar and depth = 0.7 day.

TABLE 6

MEAN CROWN DEPTH OF SEVEN WINTER WHEAT CULTIVARS AT THREE PLANTING DEPTHS UNDER GROWTH CHAMBER CONDITIONS IN FOUR DAY-NIGHT TEMPERATURE REGIMES

	Temperature (C)											
	15/7			21/12			26/18			32/23		
	Planting Depth (cm)											
Cultivar	7.5	10.0	12.5	7.5	10.0	12.5	7.5	10.0	12.5	7.5	10.0	12.5
	Crown Depth mm											
TAM W-101	50	76	91	46	64	89	37	57	78	43	66	87
Vona	50	80	95	42	57	78	31	47	65	35	50	71
Wings	50	70	84	37	51	66	29	42	59	35	48	69
Newton	44	67	76	36	54	69	29	44	64	33	52	72
TAM 105	54	68	84	38	55	73	30	44	59	29	46	64
Triumph 64	52	79	92	44	56	75	30	41	56	31	40	59
Osage	47	67	80	37	49	64	30	40	57	29	41	59

LSD (P = 0.05) for cultivars within columns = 6 mm.

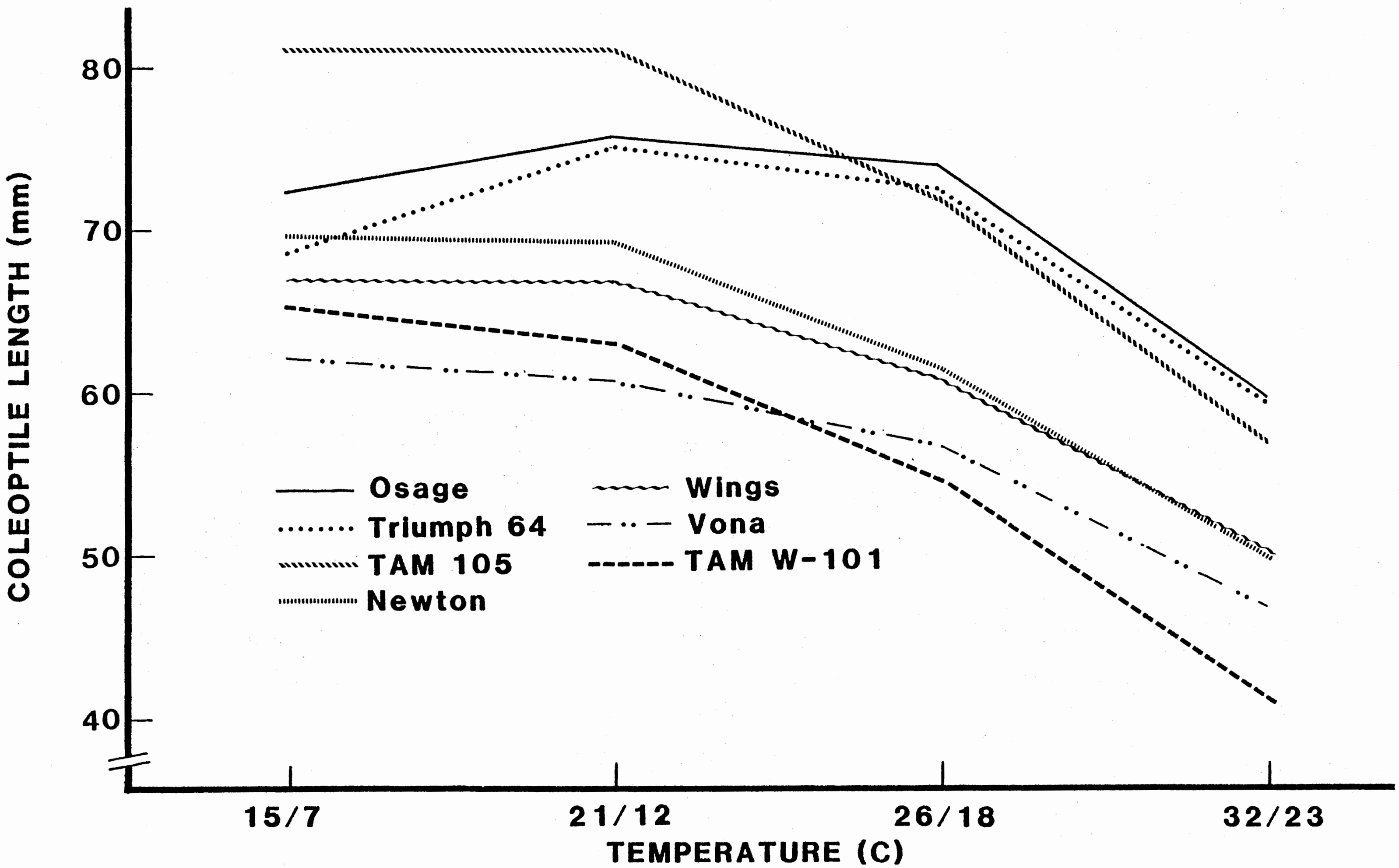

Figure 1. Effect of Temperature on Coleoptile Length of Seven Winter Wheat Cultivars Averaged Over Planting Depths. (LSD (P=0.05) for Temperature Within a Cultivar = 6).

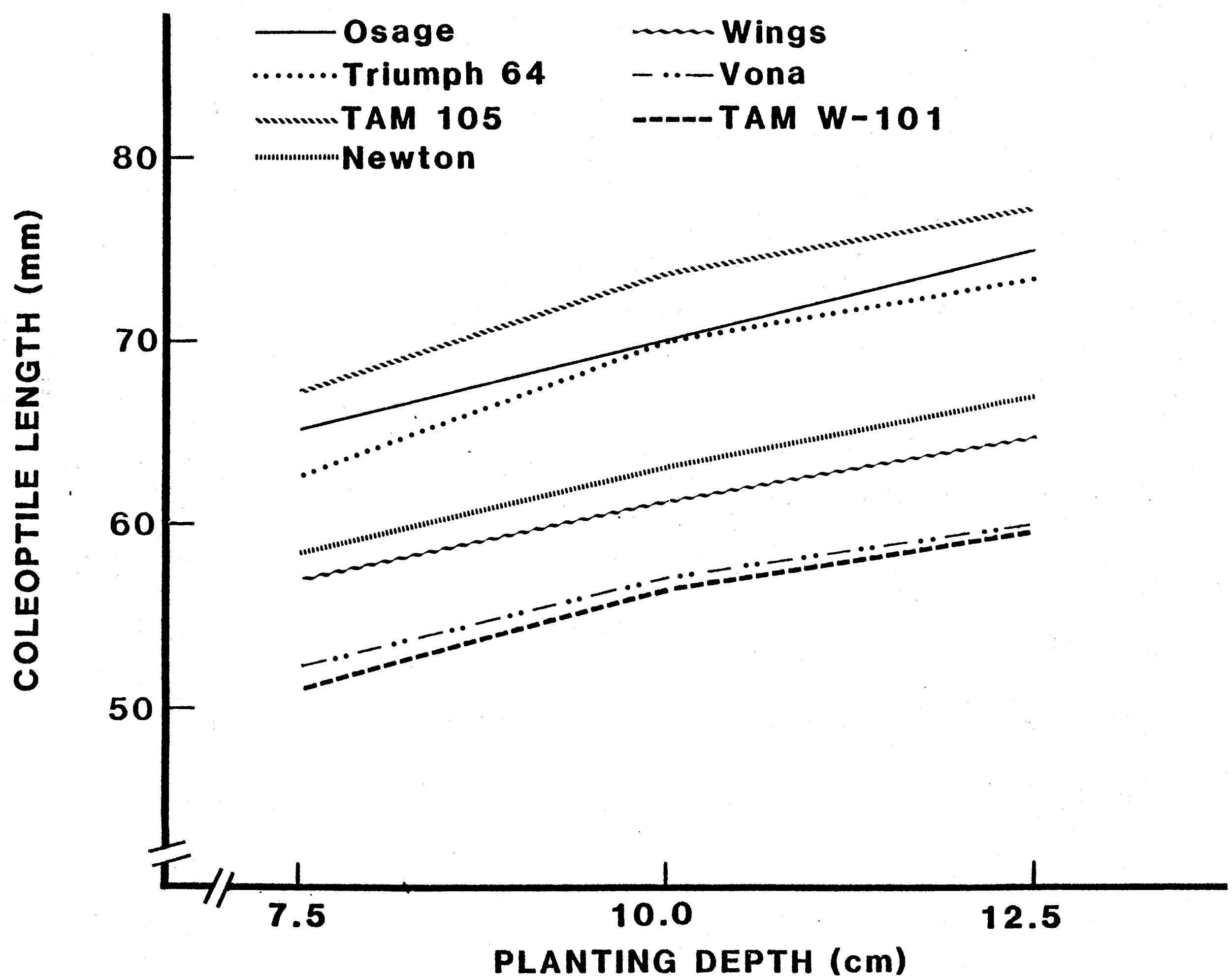

Figure 2. Effect of Planting Depth on Coleoptile Length of Seven Winter Wheat Cultivars Averaged over Temperature. (LSD (P=0.05) For Planting Depths Within a Cultivar = 2).

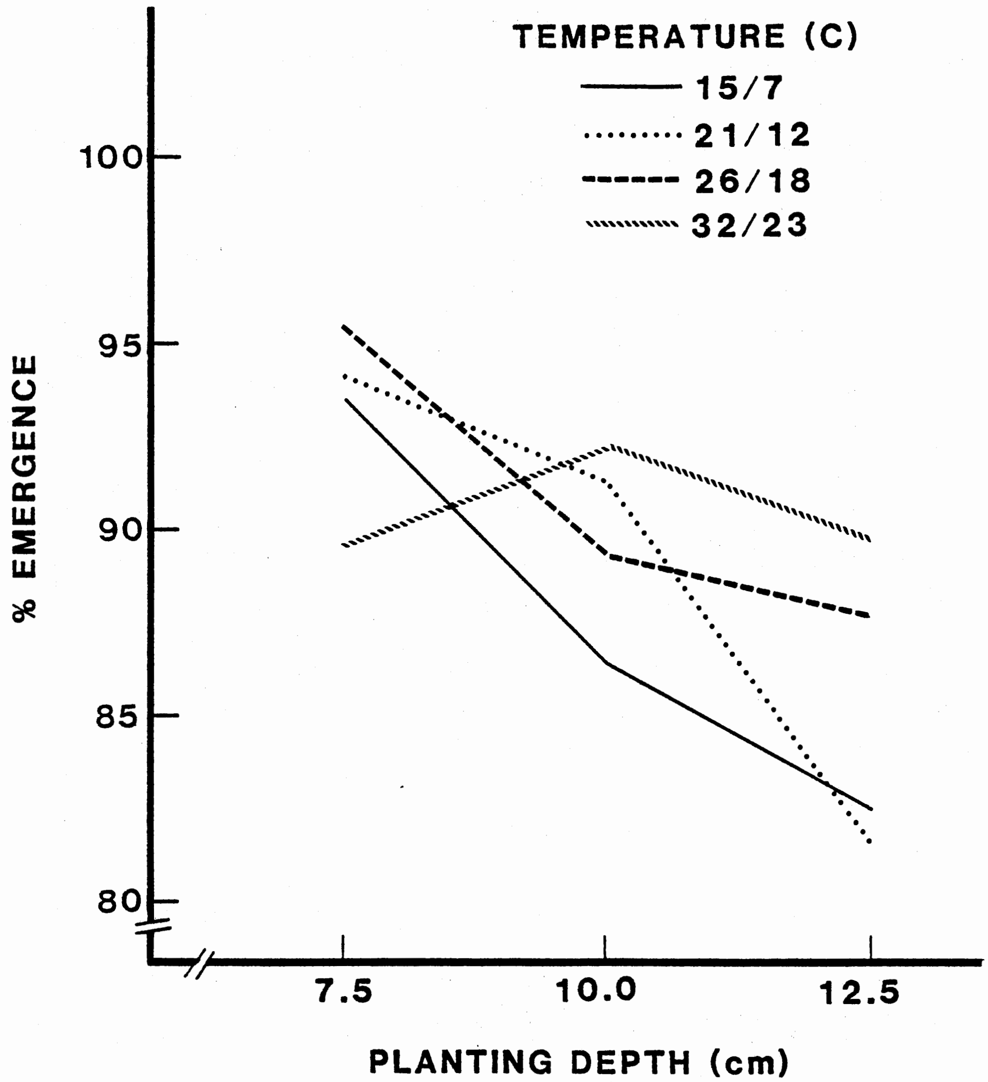

Figure 3. Effect of Planting Depth on Percent Emergence Averaged over Seven Winter Wheat Cultivars. (LSD (P=0.05) for Planting Depths Within a Temperature = 4).

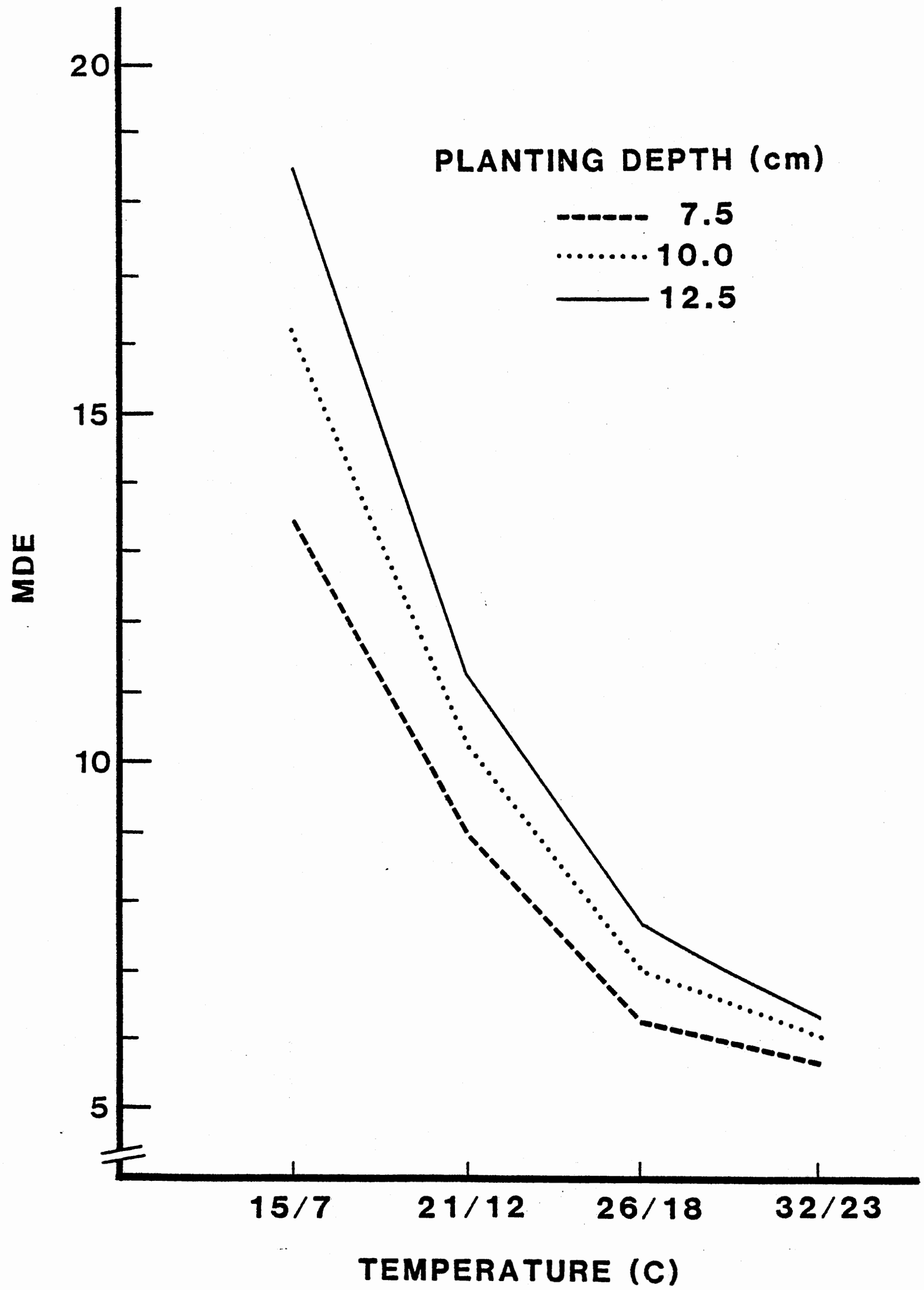

Figure 4. Effect of Temperature and Planting Depth on Mean Day to Emergence of Winter Wheat. (LSD (P=0.05) for Planting Depths Within a Temperature = 0.7).

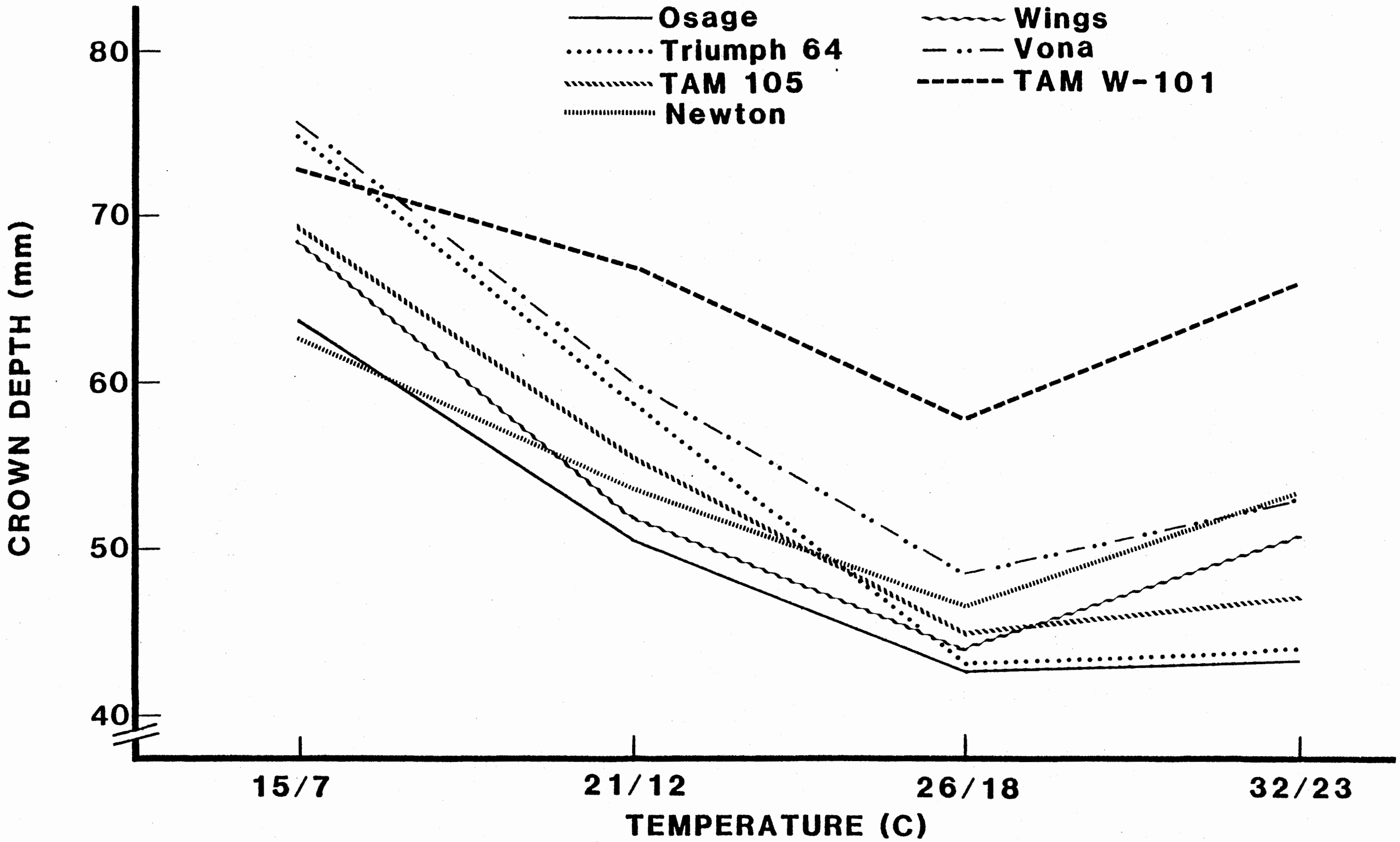

Figure 5. Comparison of Crown Depth of Seven Winter Wheat Cultivars at Four Temperature Regimes Averaged Over Planting Depths.

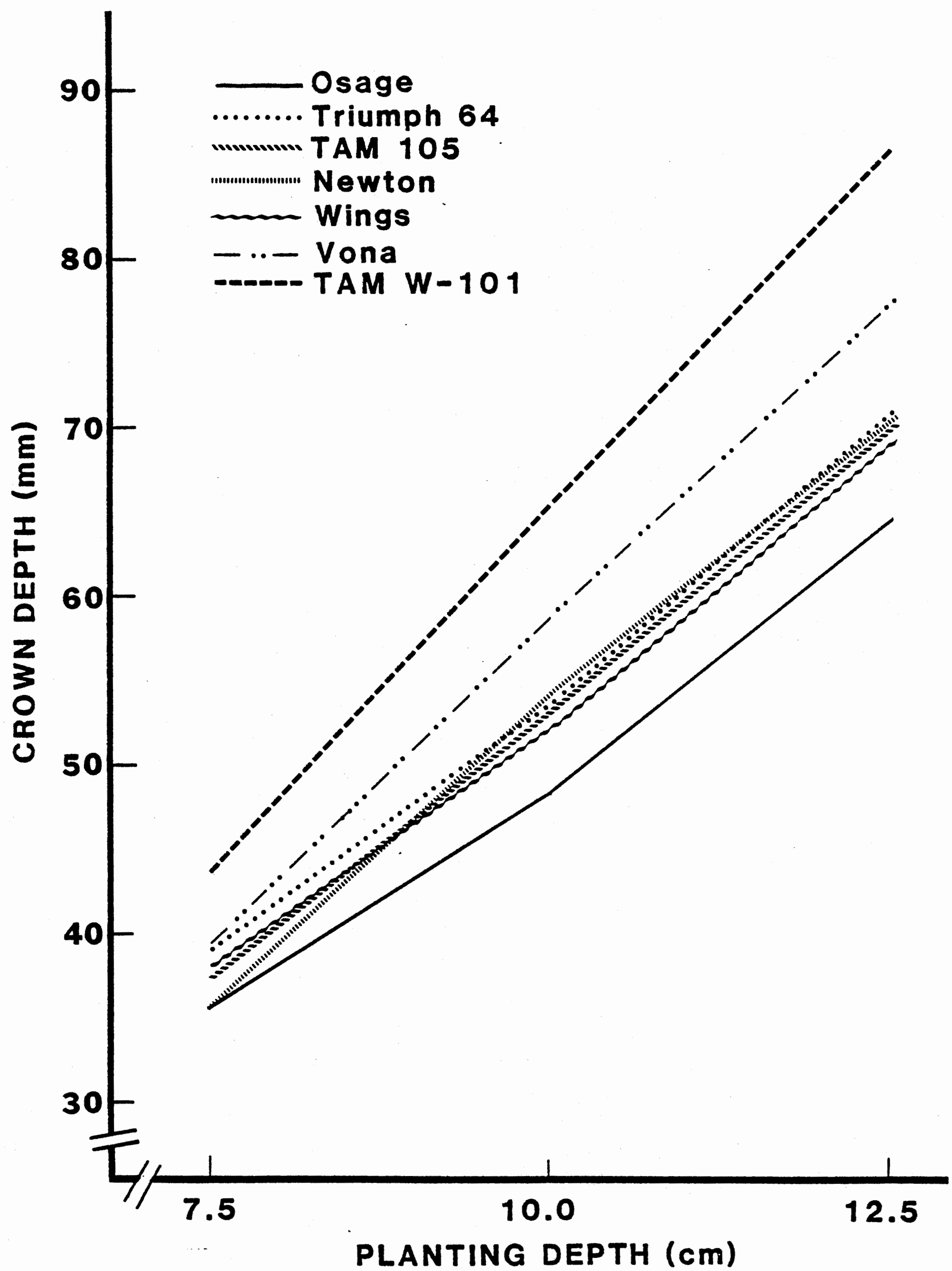

Figure 6. Comparison of Crown Depth of Seven Winter Wheat Cultivars at Three Planting Depths Averaged Over Temperatures (LSD (P=0.05) for Planting Depths Within a Cultivar = 5).

CHAPTER III

PLANTING DEPTH AND SEED SIZE EFFECTS ON SEVERAL SEEDLING EMERGENCE TRAITS AND YIELD OF WINTER WHEAT

Abstract

Four winter wheat (Triticum aestivum L.) cultivars, commonly grown in Oklahoma, were studied under field conditions to evaluate the effect of planting depth and seed size on coleoptile length, crown depth, percent emergence, tiller production and grain yield. Experiments were conducted at three Oklahoma locations on a Dale silt loam (fine-silty, mixed, thermic, pachic haplustoll) and a Norge loam and Norge fine sandy loam (fine-silty, mixed, thermic, udic paleustoll). One semidwarf ('TAM W-101'), two tall semidwarfs ('TAM 105', 'Wings') and one tall cultivar ('Triumph 64') were sown at three depth settings by a furrow drill. In general, the semidwarf (TAM W-101) had the shortest coleoptile length and lowest percent emergence while the tall semidwarf (TAM 105) and the tall cultivar (Triumph 64) had the longest coleoptiles and highest percent emergence at each location. Coleoptile length in most instances increased with increased planting depth. Cultivar

emergence generally decreased with increased planting depth but only affected yield and tiller number at Stillwater. Crown depth increased with increased planting depth with TAM W-101 generally forming the deepest crowns. The effect of seed size on the traits studied was significant in some instances but generally was considered of little practical importance.

Additional index words: *Triticum aestivum* L., Coleoptile length, Crown depth, Emergence, Tiller number.

Introduction and Literature Review

Oklahoma wheat farmers are often faced with a dry soil surface at planting time. In these situations they frequently plant deep enough to reach moisture which can result in drastic reductions in the emergence of the winter wheat seedlings.

Several workers have noted the importance of coleoptile length in the emergence of winter wheat. Burleigh et al. (3) and Whan (18) observed that standard height varieties had longer coleoptiles than semidwarfs and generally a higher percent emergence when sown at depths ranging from 4 to 15 cm. Field studies conducted by Sundermann (14) found coleoptile length to be correlated with emergence (ranging from r = 0.82 to 0.93) at depths of 7.5 to 12.5 cm and plant height (ranging from r = 0.70 to 0.76). He also noted that coleoptile length in laboratory tests were highly correlated with coleoptile lengths in the field ($r = > 0.90$). Coleoptile length has been reported to increase with planting depth in both field and laboratory studies (2, 14).

Seed size may also have an effect on the emergence of small grain seedlings. Ceccarelli and Pegiati (4) found that variable seed weight within a cultivar had no effect on coleoptile length in barley. Kaufmann (11), however, noted that large seed had significantly longer coleoptiles than small seed of the same cultivar in barley but field emergence was reduced in only one of seven tests by the use of small seed (10).

Several researchers have examined the effect of seed size, of the same cultivar, on yield and tiller production. Waldron (16), in studying spring wheat, reported that when two seed sizes were sown, either by equal weight or kernel number, the heavier kernel had significantly higher yields. Kiesselbach (12) observed that small seed yielded 10% less when equal numbers were sown and 5% less when equal weights were sown compared to large seed. Kaufmann and McFadden (10) found that large seed produced more tillers and greater yield than small, medium, or bulkseed when sown in equal numbers. In another study (8), the number of grain bearing tillers was reduced linearly with sowing depth and large seed produced significantly more tillers than small seed at depths of 10, 15 and 20 cm.

Planting depth and cultivars may also affect crown depth, a trait that some believe to be important for winter survival. Several workers (6, 7, 13, 16, 17) suggest that cultivars with deep crowns are more winterhardy. Ashraf and Taylor (2), however, reported winter survival to be associated with shallow crowns. Webb and Stephen (17) observed genotypic variation for subcrown internode elongation which determines crown depth. In another study (1), subcrown internode length was closely associated with coleoptile length (r = 0.79) and culm length (r = 0.77). Coleoptile length, subcrown internode length, and total seedling emergence were also positively interrelated in most wheat selections in a study conducted by Chowdhry and Allan (5).

Many of the seedling emergence traits that appear important in emergence and winter survival of small grains have been studied under laboratory conditions. Although some studies have been conducted in the field, further testing of these traits under field conditions is needed. Therefore, the objective of this study was to evaluate (under field conditions) the effect of planting depth and seed size on the coleoptile length, crown depth, percent emergence, tiller production and grain yield of four winter wheat cultivars commonly grown in Oklahoma.

Methods and Materials

Field experiments were conducted at three Oklahoma locations. Experiments were sown at Lamont on September 21, 1981 and October 5, 1982 on Dale silt loam (fine-silty, mixed, thermic, pachic haplustoll), Kingfisher on October 6, 1981 on Norge fine sandy loam (fine-silty, mixed thermic udic paleustoll), and Stillwater on November 16, 1981 on Norge loam (fine-silty, mixed thermic, udic paleustoll). Soil moisture at planting time was adequate at all locations. Average maximum and minimum temperature for the two week period following planting at each location was 32/17 (Lamont 1981)[1], 26/9 (Lamont 1982), 22/12 (Kingfisher 1981), and 17/2 C (Stillwater 1981). Plots were 1.5 x 3 m in 1981 and 1.5 x 4.6 m in 1982, and were sown with a furrow drill at three depth settings. Average planting depths at the four locations are shown on Table 1. The deepest setting was the maximum depth at which the planter would operate under these soil conditions. The experiment was a split plot design with planting depths as main plots and cultivar-seed size combinations as subplots. There were four replications.

Four winter wheat cultivars consisting of 'TAM W-101' (semidwarf), 'Wings', 'TAM 105' (tall semidwarfs), and 'Triumph 64' (tall) were studied. Selection of cultivars was based on previous knowledge of mature plant height since plant height and coleoptile length have been reported to be highly correlated (14). Certified seed of each cultivar

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[1]Climatological Data of Oklahoma, 1981-82, The National Oceanic and Atmospheric Administration.

treated with carboxin was used. Laboratory germination of each cultivar was above 90%. The seed lots of each cultivar were divided into seed size categories by passing them through a series of four sieves. Large seed was that which remained on top of a 2.8 x 19 mm (7/64 x 3/4 in) sieve and small seed on top of a 2.2 x 19 mm (5 1/2 / 64 x 3/4 in) sieve. Seed was sown on an equivalent weight basis at a rate of 33.6 kg/ha. The different seed sizes did result in slightly different plant populations (Table 2). It is felt, however, that these differences were not large enough to affect tiller or grain yield data.

Twenty seedlings were removed (in consecutive order) from each plot after the crown developed. Coleoptile length, subcrown internode length, planting depth and percent emergence were recorded. Planting depth was determined by measuring the distance from the seed to a spray paint marking placed at the soil surface before the plants were removed. Crown depth was calculated by subtracting the subcrown internode length from the planting depths. Since crown depth is inversely correlated with subcrown internode length, only data for crown depth will be reported in this paper. Tiller number, grain yield and plant height were obtained from two one meter rows from each plot at both Kingfisher and Stillwater.

Since actual planting depth varied slightly within each depth setting due to variable soil conditions, it was necessary to analyze the data by covariance analysis so plot means could be adjusted to the average actual planting depth.

Results

The analysis of covariance revealed significant differences between environments, consequently the data is presented by locations (Table 3). Cultivars were significant for all traits at each environment except for percent emergence and crown depth at Stillwater. Planting depth had a significant effect on all traits except tiller number, yield (Kingfisher) and plant height. Seed size had no effect on plant height, tiller number or grain yield. All interactions involving these traits were nonsignificant. However, seed size did affect coleoptile length at Kingfisher and Lamont 1982, percent emergence at Kingfisher, and crown depth at all locations except Lamont 1982. The only interaction of significance for crown depth was planting depth by cultivar at Lamont 1981 and 1982. The planting depth by cultivar interaction for coleoptile length was significant at all locations except at Stillwater while the cultivar by seed size interaction was significant only at Lamont 1982. All first order interactions for percent emergence at Kingfisher and Lamont 1981 were significant, except for planting depth by seed size (Kingfisher), while only the planting depth by seed size and planting depth by cultivar interactions were significant at Stillwater and

Lamont in 1982, respectively. The significant second order interactions for coleoptile length occurred at Lamont 1981 and 1982 and at Kingfisher and Lamont 1981 for percent emergence.

Coleoptile Length

The mean coleoptile length for each cultivar when sown at different depths and seed sizes is presented in Table 4. In general, the semidwarf (TAM W-101) had the shortest coleoptile while the tall semidwarf (TAM 105) and the tall cultivar (Triumph 64) had the longest coleoptiles at each location. The only exception to this trend occurred at Stillwater where Triumph 64 had the shortest coleoptile. TAM 105 generally had a significantly longer coleoptile than Triumph 64 at the two deeper planting depths at Lamont 1982 and Stillwater. Coleoptile length, in most instances, increased with increased planting depth, with the largest increases occurring between the shallow and intermediate depths at each location.

Seed size had an effect on coleoptile length at Kingfisher and Lamont 1982. Coleoptile lengths for the two seed sizes responded uniformly over cultivars and planting depths at Kingfisher with small seed having a shorter coleoptile than the large seed. At Lamont 1982, the small seed of Triumph 64 had significantly shorter coleoptiles than large seed at all depths while small seed of TAM 105 and TAM W-101 had shorter coleoptiles at the 9.5 cm depth.

Percent Emergence

The effect of cultivar, planting depth, and seed size on percent emergence is presented in Figure 1. In general, the semidwarf (TAM W-101) had the lowest percent emergence, especially at the deepest planting depth, except at Stillwater where no cultivar differences were observed. No significant differences among cultivars were detected at the shallow or intermediate planting depths at Lamont 1982 or the shallow depth for Kingfisher.

Increased planting depth generally resulted in reduced emergence. Significant differences in percent emergence at Stillwater generally occurred between the 7.5 and 8.0 cm depth, except for TAM 105 which was not affected by planting depth. At Lamont 1982, reduction in percent emergence among the cultivars was relatively consistent between the 6.0 and 9.0 cm depths. At the 9.5 cm depth, however, TAM W-101 and Wings had a more drastic reduction in emergence than TAM 105 or Triumph 64. Increased planting depth had no effect on emergence for the tall cultivar (Triumph 64) or the large seed of Wings at Lamont 1981. The greatest reduction in emergence for all cultivars generally occurred between 9.0 and 10.5 cm depths at Kingfisher and 6.0 and 9.0 cm depths at Lamont 1982.

Emergence differences due to seed size were detected at Kingfisher where the small seed of TAM W-101 had significantly lower emergence than the large seed at the two deeper planting depths. The same was true for Wings at the 10.5 cm depth. Even though the analysis of covariance indicated no significant differences between seed sizes at Lamont 1981, TAM W-101 and Wings had 15-20% lower emergence than large seed at the 10.0 cm depth while small seed of TAM 105 had 15% higher emergence at the same depth.

Crown Depth

The effect of planting depth and seed size on crown depth for the four cultivars studied is presented in Table 5. TAM W-101 generally formed the deepest crowns while the other three cultivars (Wings, TAM 105, Triumph 64) formed a group having shallower crowns at Lamont in 1981 and 1982. This was especially evident at the two deeper planting depths. At Kingfisher, however, TAM 105 tended to form shallower crowns than all other cultivars. The analysis of covariance indicated no significant differences in crown depth for cultivars at Stillwater.

Crown depth increased with planting depth at all locations. The deepest crowns occurred at Stillwater. Small seed had significantly deeper crowns than large seed when averaged over cultivars and planting depths at both Lamont 1981 and Kingfisher while the opposite held true for Stillwater. These differences were small, however, and are probably of little practical importance for winter survival.

Plant Height, Tiller Number and Yield

Mature plant height for each cultivar at the three locations is presented in Table 6. Plant heights were consistent with established height classifications for the cultivars with the tall semidwarfs (TAM 105 and Wings) being significantly taller than the semidwarf TAM W-101, and shorter than the tall cultivar Triumph 64. The only exception was at Stillwater where the semidwarf (TAM W-101) and the tall semidwarf (Wings) did not differ from one another.

Increased planting depth resulted in a decrease in tiller number at Stillwater and yield was the lowest for the 8.0 cm depth (Table 7). TAM W-101 and Wings had more tillers than Triumph 64 at Stillwater while Wings and TAM 105 had a greater number than TAM W-101 and Triumph 64 at Kingfisher, although the differences were not always significant. TAM 105 and TAM W-101 generally had the lowest yield at Stillwater and Kingfisher, respectively.

Correlations

Correlation coefficients of all possible variable combinations at each planting depth were determined for each location with correlations of interest presented in Table 8. A significant correlation between yield and tiller number was obtained in 5 of 6 tests at Kingfisher and Stillwater (r ranging from 0.56 to 0.85). Positive correlations between coleoptile length and percent emergence occurred in 8 of 12 tests over all locations, but they were generally small (r ranging from 0.12 to 0. 48). Coleoptile length was negatively correlated with crown depth at Stillwater in 2 of 3 tests (r ranging from -0.43 to -0.59). Correlations involving other variable combinations were not significantly different from zero.

Discussion

Previous work has shown that standard height cultivars have longer coleoptiles and better emergence from deep plantings than semidwarfs (3, 18). My results are in general agreement with these reports. The exception to this trend, however, was TAM 105 (a tall semidwarf) which was equal to the tall cultivar, Triumph 64, for coleoptile length. Evidently the linkage that exists between coleoptile length and mature plant height was at least partially or fully broken in this case. Average maximum and minimum air temperatures for the two week period following planting were obtained from local weather records which may help explain some of the differences noted between cultivars for coleoptile length. Average temperatures at Lamont 1981 were 32/17 C. Here Triumph 64 and TAM 105 had similar coleoptile lengths. At Stillwater and Lamont 1982, TAM 105 generally had longer coleoptiles than Triumph 64 at temperatures of 17/2 and 26/9 C, respectively. Triumph 64 had the shortest coleoptiles at Stillwater, differing only slightly from

Wings and TAM W-101 at 17/2 C. Similar results in an earlier growth chamber study (9) found coleoptile lengths of TAM 105 to exceed that of Triumph 64 at 15/7 and 21/12 with Triumph 64 having slightly longer coleoptiles at 32/23 C. At 15/7 C, Triumph 64 was found to have slightly longer coleoptiles than Wings or TAM W-101. The effect of planting depth on coleoptile length was also in agreement with other studies (2, 14).

No significant correlations between mature plant height and coleoptile length were observed, as were found by Sundermann (14). This may have resulted from similar coleoptile lengths of the tall semidwarf (TAM 105) and the tall cultivar, Triumph 64. At Stillwater, Triumph 64 had the shortest coleoptile of all cultivars. There were, however, small positive correlations between emergence and coleoptile length in 8 of 12 tests.

Previous results (4, 11) have varied as to the effect of seed size on coleoptile length. This was also observed in this study with significant differences in coleoptile length occurring only at Kingfisher and Lamont 1982. At these two locations, large seed generally had longer coleoptiles than small seed. The effect of these differences on percent emergence, however, were inconsistent with longer coleoptiles having better emergence in some instances and lower in others. Therefore, differences in coleoptile length due to seed size is considered of little practical importance for percent emergence.

My work was in general agreement with earlier reports which found increased planting depth to reduce percent emergence (3, 14, 18). The differences in percent emergence at Stillwater were not as dramatic as Kingfisher, but were evidently enough to cause the observed reduction in tiller number and yield. Reduced emergence at Kingfisher, resulting from increased planting depth and different seed size, did not affect yield or tiller numbers as might be expected. This may have resulted from the excellent growing conditions during the growing season which helped compensate poor emergence with high tiller production or perhaps, in some instances, the sample taken to determine percent emergence was not representative of the plot. Different soil types and possible surface crusting, formed before the seedlings' emergence, may have also contributed to observed differences in percent emergence between locations. The lower yield and tiller number at Stillwater was probably a result of the later planting date (reducing tiller number). The deepest planting depth at Stillwater was not as deep as the intermediate planting depth at all other locations and may have accounted for the lack of cultivar difference for percent emergence and crown depth.

The response of crown depth to planting depth and the variation noted between cultivars agrees with other workers (15, 17). Mature plant height did somewhat correspond to crown depth in that the semidwarf generally had the deepest crown and the tall semidwarfs and tall cultivar had shallower crowns. The deepest crowns occurred at Stillwater where temperatures were the lowest, which agrees with others (9, 15).

In conclusion, the semidwarf, TAM W-101, generally had shorter coleoptiles and lower percent emergence than the tall semidwarf TAM 105 or the tall cultivar, Triumph 64, especially at the deeper planting depth. Increased planting depth reduced emergence but only affected yield and tiller number at Stillwater. Crown depth increased with increased planting depth with TAM W-101 generally forming the deepest crowns. The effect of seed size on the traits studied was significant in some instances but generally were considered of little practical importance.

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TABLE 1

AVERAGE PLANTING DEPTH OF WINTER WHEAT
AT FOUR OKLAHOMA LOCATIONS

Locations	Depth 1	Depth 2	Depth 3
		(cm)	
Kingfisher	6.0	9.0	10.5
Stillwater	4.5	7.5	8.0
Lamont - 1981	6.5	9.0	10.0
Lamont - 1982	6.0	9.0	9.5

TABLE 2

THOUSAND KERNEL WEIGHT AND PLANT POPULATION OF FOUR
WINTER WHEAT CULTIVARS SOWN AT 33.6 kg/ha.

Cultivar	Seed size	Kernel weight	Plants/ ha	Plants/ linear meter
		(mg)	(x 1000)	
TAM W-101	Small	49.9	674	17.1
	Large	57.2	588	14.9
TAM 105	Small	47.6	706	18.0
	Large	57.1	589	15.0
Wings	Small	46.4	725	18.5
	Large	53.5	628	16.0
Triumph 64	Small	46.8	718	18.3
	Large	53.7	626	15.9

TABLE 3

ANALYSIS OF COVARIANCE OF SIX WINTER WHEAT TRAITS
AT FOUR OKLAHOMA ENVIRONMENTS

		Source of Variation							
Location	Trait	Depth	Cultivar	Seed size	CxS	DxC	DxS	DxCxS	C.V. (%)
	<u>Coleoptile Length</u>								
Stillwater		**	**	NS	NS	NS	NS	NS	7.34
Kingfisher		**	**	*	NS	**	NS	NS	6.19
Lamont 1981		**	**	NS	NS	*	NS	**	5.89
Lamont 1982		**	**	**	**	**	NS	*	5.37
	<u>Percent Emergence</u>								
Stillwater		*	NS	NS	NS	NS	*	NS	10.09
Kingfisher		**	**	*	**	**	NS	*	10.91
Lamont 1981		**	**	NS	*	**	*	*	8.75
Lamont 1982		**	*	NS	NS	*	NS	NS	17.80
	<u>Crown Depth</u>								
Stillwater		**	NS	**	NS	NS	NS	NS	7.44
Kingfisher		**	**	**	NS	NS	NS	NS	10.35
Lamont 1981		**	**	**	NS	**	NS	NS	11.14
Lamont 1982		**	**	NS	NS	*	NS	NS	12.68

TABLE 3 (Continued)

		Source of Variation							
Location	Trait	Depth	Cultivar	Seed size	CxS	DxC	DxS	DxCxS	C.V. (%)
	Tillers								
Stillwater		*	*	NS	NS	NS	NS	NS	17.17
Kingfisher		NS	*	NS	NS	NS	NS	NS	18.06
	Yield								
Stillwater		*	**	NS	NS	NS	NS	NS	18.23
Kingfisher		NS	**	NS	NS	NS	NS	NS	21.53
	Plant Height								
Stillwater		NS	*	NS	NS	NS	NS	NS	2.98
Kingfisher		NS	**	NS	NS	NS	NS	NS	5.86
Lamont 1981		NS	**	NS	NS	NS	NS	NS	5.97

*,**Significant at the 0.05 and 0.01 levels of probability, respectively.

TABLE 4

MEAN COLEOPTILE LENGTH OF FOUR WINTER WHEAT CULTIVARS AT THREE PLANTING DEPTHS AND TWO SEED SIZES FOR FOUR OKLAHOMA ENVIRONMENTS

	Lamont 1981 Planting depth (cm)					
	6.5		9.0		10.0	
Cultivars	Small Seed	Large Seed	Small Seed	Large Seed	Small Seed	Large Seed
	mm					
TAM W-101	45a*	46a	45a	47a	46a	47a
Wings	48a	46a	52b	51a	48a	55b
TAM 105	49a	54b	57b	56b	57b	51b
Triumph 64	54b	54b	62c	64c	61b	62c
	Lamont 1982 Planting depth (cm)					
	6.5		9.0		9.5	
TAM W-101	48ab	46a	51a	55a	47a+	52a
Wings	46a	50a	54ab	52a	55b	59b
TAM 105	54c	57b	65d	68b	66d+	72d
Triumph 64	52bc+	57b	56c+	70b	61c+	66c

TABLE 4 (Continued)

Cultivars	Kingfisher Planting depth (cm) 6.0 Small Seed	6.0 Large Seed	9.0 Small Seed	9.0 Large Seed	10.5 Small Seed	10.5 Large Seed
	mm					
TAM W-101	43a	42ab	51a	54a	5^{1+}	56a
Wings	39a	37a	54ab	56a	56b	59ab
TAM 105	43a	43b	59bc	64c	64c	62bc
Triumph 64	43a	43b	61c	61c	59bc	64c

Cultivars	Stillwater Planting depth (cm) 4.5 Small Seed	4.5 Large Seed	7.5 Small Seed	7.5 Large Seed	8.0 Small Seed	8.0 Large Seed
TAM W-101	37ab	36a	62a	62ab	63b	67a
Wings	36a	40a	60a	63ab	66b	65a
TAM 105	42b	38a	68b	66b	72c	70b
Triumph 64	38ab	36a	56a	58a	56a	62a

* Means followed by the same letter are not significantly different at P = 0.05.
+ Seed sizes within a cultivar at each planting depth differ at P = 0.05.

TABLE 5

MEAN CROWN DEPTH OF FOUR WINTER WHEAT CULTIVARS AT THREE PLANTING DEPTHS AND TWO SEED SIZES FOR FOUR OKLAHOMA ENVIRONMENTS

	Lamont 1981 Planting depth (cm)					
	6.5		9.0		10.0	
Cultivars	Small Seed	Large Seed	Small Seed	Large Seed	Small Seed	Large Seed
	mm					
TAM W-101	27a*	25a	44b	44b	53b+	46c
Wings	28a	25a	35a	34a	38a	39b
TAM 105	26a	23a	35a	32a	39a	39b
Triumph 64	30a*	24a	34a	33a	37a	33a
	Lamont 1982 Planting depth (cm)					
	6.0		9.0		9.5	
TAM W-101	28a	30a	41b	41a	51b	51b
Wings	26a	25a	33a	37a	44b	35a
TAM 105	25a	26a	35b	37a	34a	38a
Triumph 64	28a	31a	34ab	37a	37a	39a

TABLE 5 (Continued)

	Kingfisher Planting depth (cm)					
	6.0		9.0		10.5	
Cultivars	Small Seed	Large Seed	Small Seed	Large Seed	Small Seed	Large Seed
	mm					
TAM W-101	30a	31ab	39a	36ab	47b[+]	37ab
Wings	38b	35bc	40a	37ab	44ab	41bc
TAM 105	33ab	29a	35a	32a	41a[+]	35a
Triumph 64	36b	38c	39a	39b	42ab	44c
	Stillwater Planting depth (cm)					
	4.5		7.5		8.0	
TAM W-101	36a	39a	47ab	50a	52ab	51a
Wings	38a	38a	50b	50a	48a[+]	56b
TAM 105	33a[+]	39a	44a[+]	50a	50ab	53ab
Triumph 64	36a	37a	51b	51a	55b	55ab

[*] Means followed by the same letter are not significantly different at P = 0.05.
[+] Seed sizes within a cultivar at each planting depth differ at P = 0.05.

TABLE 6

MEAN PLANT HEIGHT OF FOUR WINTER WHEAT CULTIVARS AVERAGED OVER PLANTING DEPTH AND SEED SIZE AT THREE OKLAHOMA ENVIRONMENTS

	Plant height (cm)		
	Location		
Cultivar	Stillwater	Kingfisher	Lamont 1981
	cm		
TAM W-101	75a*	78a	85a
Wings	75a	84b	96b
TAM 105	77b	83b	99b
Triumph 64	86c	91c	110c

*Means followed by the same letter are not significantly different at P = 0.05.

TABLE 7

MEAN TILLER NUMBER AND YIELD OF FOUR WINTER WHEAT CULTIVARS AT THREE PLANTING DEPTHS AVERAGED OVER SEED SIZE FOR STILLWATER AND KINGFISHER

	Stillwater					
	Planting depth (cm)					
	4.5		7.5		8.0	
Cultivar	Yield	Tiller No.	Yield	Tiller No.	Yield	Tiller No.
	kg/ha	tillers/ meter row	kg/ha	tillers/ meter row	kg/ha	tillers/ meter row
TAM W-101	967.2a	80a	1150.3b	81b	980.1ab	67ab
Wings	1072.7ab	82a	1262.3b	75b	945.7ab	69b
TAM 105	977.6ab	76a	913.4a	71b	797.0a	63ab
Triumph 64	1161.1b	72a	1163.1b	65a	1025.4b	55a
	Kingfisher					
	Planting depth (cm)					
	6.0		9.0		10.5	
TAM W-101	1839.6a*	160a	1703.9a	137a	2268.3a	156a
Wings	2395.4b	176a	2449.1b	173b	2533.3a	174a
TAM 105	2393.3b	182a	2320.0b	174b	2429.9a	171a
Triumph 64	2093.8ab	161a	2507.4b	158ab	2664.7a	160a

* Means followed by the same letter are not significantly different at P = 0.05.

TABLE 8

CORRELATION COEFFICIENT VALUES AMONG SEVERAL MEASUREMENTS OBTAINED ON WINTER WHEAT AT FOUR OKLAHOMA ENVIRONMENTS

Measurements compared	Depth setting	Locations			
		Stillwater	Kingfisher	Lamont 1981	Lamont 1982
		r			
Yield/tiller number	1	0.71**	0.68*		
	2	0.39	0.85**		
	3	0.56**	0.75**		
Coleoptile length/ percent emergence	1	0.12	-0.18	0.16	-0.02
	2	-0.33	0.40	0.32	0.39
	3	0.48	0.24	0.28	-0.10
Coleoptile length/ crown depth	1	-0.43*			
	2	-0.59*			
	3	-0.29			

*,**Significant at the 0.05 and 0.01 levels of probability, respectively.

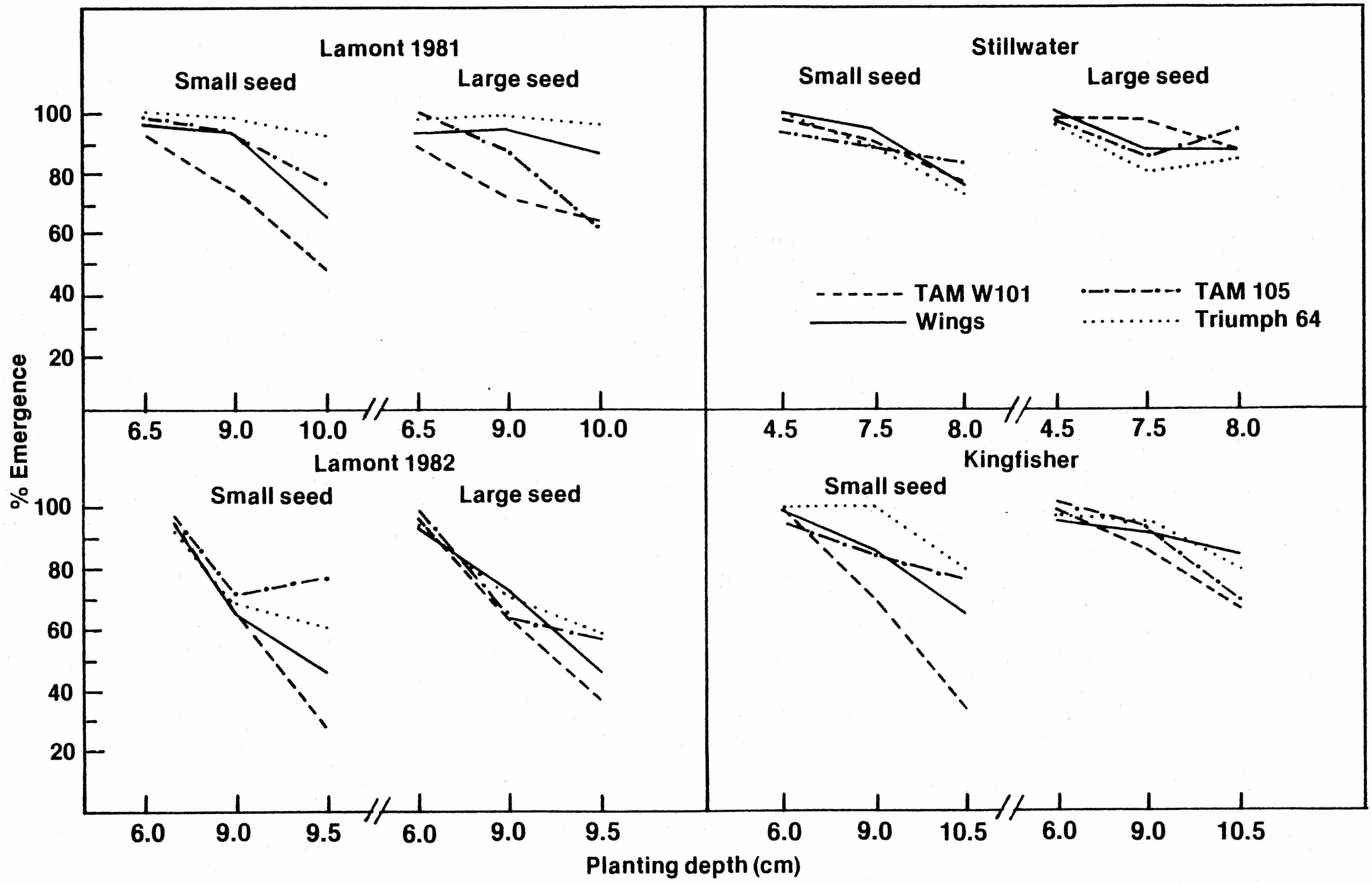

FIG 1. MEAN PERCENT EMERGENCE OF FOUR WINTER WHEAT CULTIVARS AT THREE PLANTING DEPTHS AND TWO SEED SIZES FOR FOUR OKLAHOMA ENVIRONMENTS.

CHAPTER IV

SUMMARY

Two experiments were conducted to determine the effect of cultural and environmental factors on several seedling emergence traits of winter wheat. In the first experiment seven cultivars were studied under growth chamber conditions to determine the effect of temperature and planting depth on coleoptile length, percent emergence, crown depth and mean day emergence. The second experiment was performed to determine the effect of planting depth and seed size on coleoptile length, percent emergence, crown depth, tiller number and yield under field conditions.

Results from both experiments paralleled one another for coleoptile length with taller cultivars, in general, having longer coleoptiles than semidwarfs. The exception was TAM 105 (a tall semidwarf) which had coleoptile lengths similar to those of the tall cultivars. Coleoptile length generally increased with increased planting depth for both experiments, and was drastically reduced at 32/23 C in the growth chamber study.

Increased planting depth generally reduced percent emergence in field studies with cultivars having the longest coleoptiles usually having the highest percent emergence, especially at the deeper plantings. Reduced emergence only affected yield and tiller number at Stillwater, however. Cultivar differences for percent emergence for the growth chamber study were small, with differences between the two experiments likely due to different soil conditions. TAM 105 (a tall semidwarf) would be a good selection when farmers are faced with a deep sowing situation and desire a shorter-strawed cultivar while the semidwarf, TAM W-101, appears to be the least desirable cultivar.

Mean day to emergence decreased with increasing temperature and shallower planting depth, but differences observed between the cultivars were considered of little practical importance as were the seed size effects noted among the traits in the field study. TAM W-101 generally had deeper crowns than all other cultivars in both studies with the deepest crowns forming at the lowest temperatures and deepest planting depths.

APPENDIX

TABLE 1

MEAN SQUARES OF ANALYSIS OF COVARIANCE FOR SIX WINTER WHEAT CHARACTERISTICS AT STILLWATER

Source of Variation	D.F.	Coleoptile Length	Emergence	Tillers	Yield	Plant Height	D.F.	Crown Depth
Rep	3	96**	0.001	7836**	6595**	1538.73**	3	29.85
Depth	2	7081**	0.181*	1706*	595*	120.04	2	1065.33**
Error A	6	11	0.017	204	111	29.16	6	5.10
Cultivar	3	240**	0.010	729*	461**	680.69**	3	28.68
Seed size	1	9	0.017	2	47	4.83	1	131.33**
C x S	3	32	0.003	83	27	.39	3	19.29
D x C	6	30	0.007	43	85	9.27	6	8.08
D x S	2	15	0.042**	64	61	2.18	2	.009
D x C x S	6	16	0.003	18	47	2.76	6	16.03
Error B	60	16	0.008	150	77	5.42	59	11.92
C.V. (%)		7.3	10.1	17.2	18.2	3.0		7.4

*,**Significant at the 0.05 and 0.01 levels of probability, respectively.

TABLE 2

MEAN SQUARES OF ANALYSIS OF COVARIANCE FOR SIX WINTER WHEAT CHARACTERISTICS AT KINGFISHER

Source of Variation	D.F.	Coleoptile Length	Emergence	Tillers	Yield	Plant Height	D.F.	Crown Depth
Rep	3	3	0.011	1015	83	272	3	35
Depth	2	3001**	0.694**	689	1652	152	2	486*
Error A	6	6	0.005	349	3391	430	6	10
Cultivar	3	225**	0.107**	2987	2915**	662**	3	133**
Seed size	1	50*	0.059*	45	4	3	1	128**
C x S	3	4	0.039**	841	219	38	3	31
D x C	6	38**	0.036**	260	462	32	6	14
D x S	2	30	0.025	1783	661	26	2	18
D x C x S	6	11	0.021*	310	111	7	6	15
Error B	60	11	0.008	890	529	24	59	15
C.V. (%)		6.2	10.9	18.1	21.5	5.9		10.4

*,**Significant at the 0.05 and 0.01 levels of probability, respectively.

TABLE 3

MEAN SQUARES OF ANALYSIS OF COVARIANCE FOR FOUR WINTER WHEAT CHARACTERISTICS AT LAMONT 1981

Source of Variation	D.F.	Coleoptile Length	Emergence	Plant Height	D.F.	Crown Depth
Rep	3	71*	0.011	244	3	45
Depth	2	175**	0.403**	358	2	1733**
Error A	6	15	0.006	234	6	20
Cultivar	3	771**	0.223**	2377**	3	339**
Seed size	1	9	0.001	20	1	135
C x S	3	4	0.015*	37	3	8
D x C	6	28*	0.040**	21	6	98**
D x S	2	1	0.018*	23	2	9
D x C x S	6	36**	0.017*	31	6	12
Error B	60	10	0.005	34	58	15
C.V. (%)		6.0	8.8	6.0		11.1

*,**Significant at the 0.05 and 0.01 levels of probability, respectively.

TABLE 4

MEAN SQUARES OF ANALYSIS OF COVARIANCE FOR THREE WINTER WHEAT CHARACTERISTICS AT LAMONT 1982

Source of Variation	D.F.	Coleoptile Length	Emergence	D.F.	Crown Depth
Rep	3	16	.083	3	13
Depth	2	681**	1.623**	2	1545**
Error A	6	9	.008	6	2
Cultivar	3	737**	.054*	3	160**
Seed size	1	327**	.003	1	15
C x S	3	42**	.013	3	27
D x C	6	37**	.040*	6	57*
D x S	2	15	.001	2	14
D x C x S	6	25*	.011	6	22
Error	60	9	.016	58	20
C.V. (%)		5.4	17.8		12.7

*,**Significant at the 0.05 and 0.01 levels of probability, respectively.

VITA[1]

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